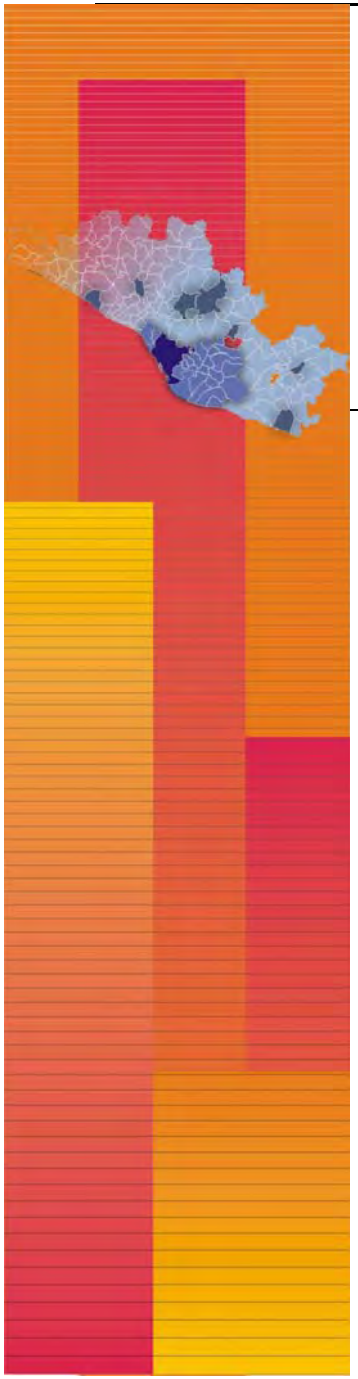

WESSEX INSTITUTE OF TECHNOLOGY
Advancing International Knowledge Transfer

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Urban Transport 2010
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The use of the city in space and time as a new social approach for prioritising transport corridors in the metropolitan area of Barcelona (Spain)

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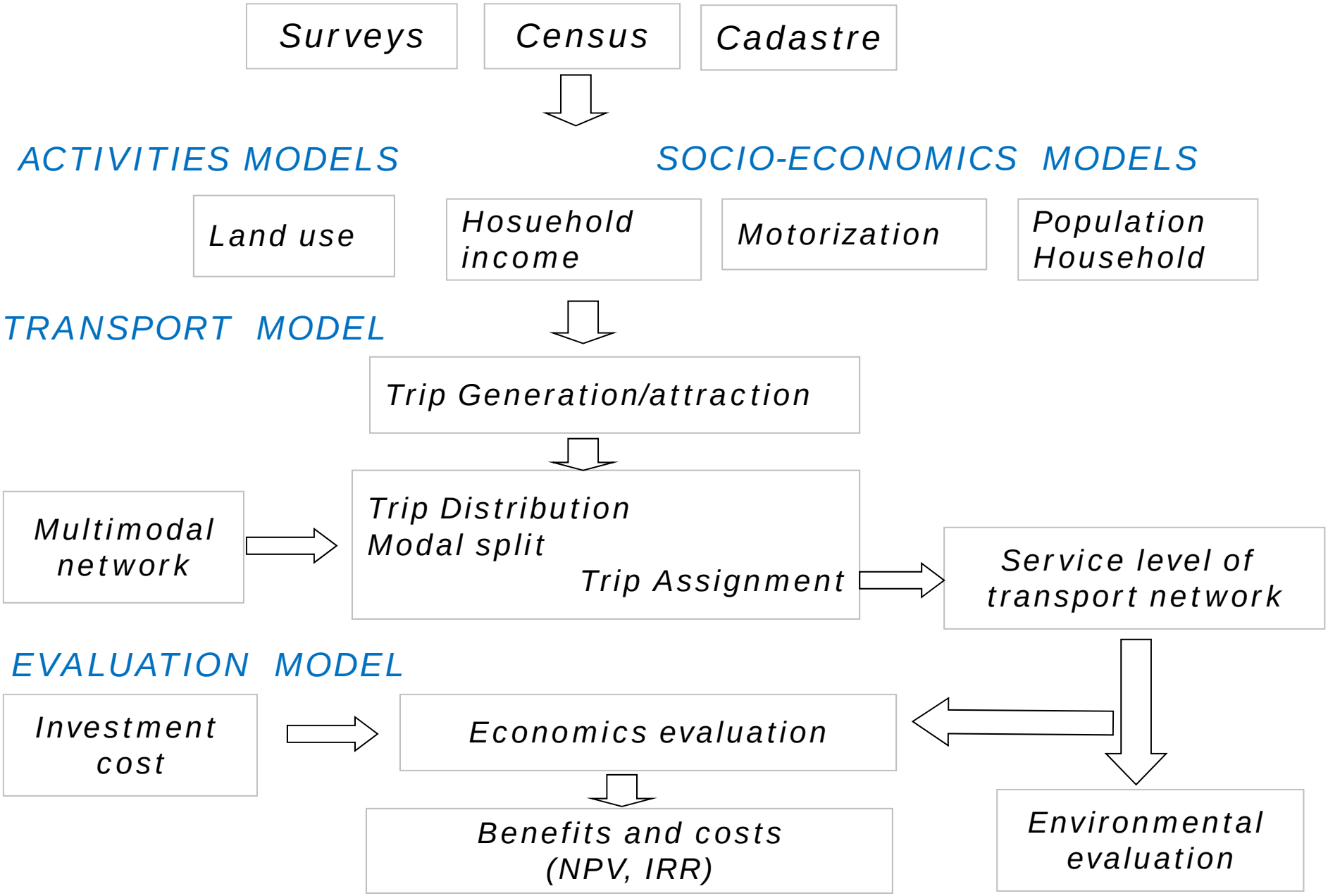
Centre of Land Policy and Valuations

Program of the presentation

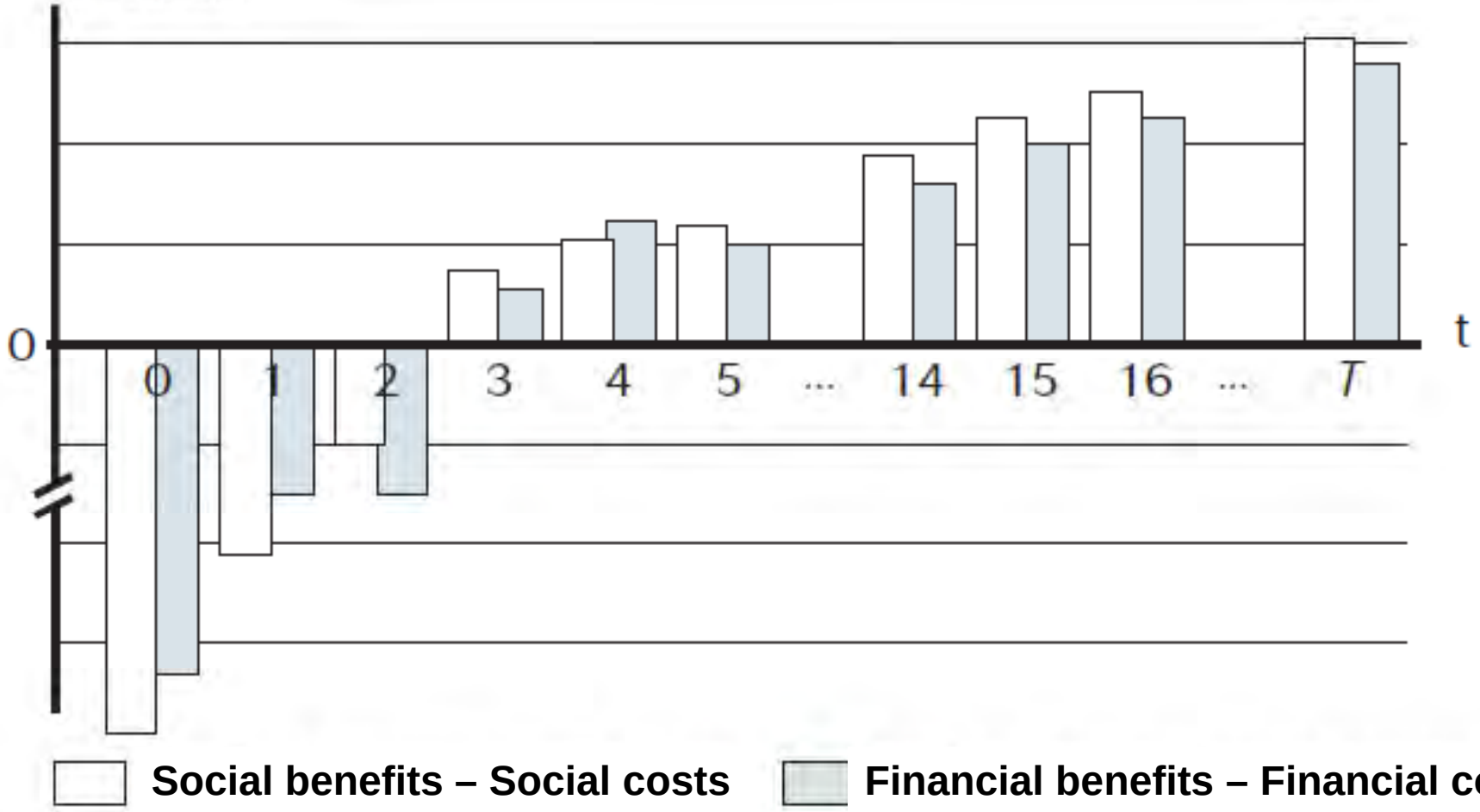
1. **Introduction: evaluation of transport projects**
2. **Basic question and objective**
3. **Approach (methodology): the use of the city**
4. **Results**
5. **Main conclusions and new line**

Introduction : evaluation of transport projects


Surveys
Census
Cadastre
ACTIVITIES MODELS
SOCIO-ECONOMICS MODELS
Land use
Hosuehold income
Motorization
Population Household
TRANSPORT MODEL
Trip Generation/attraction
Multimodal network
Trip Distribution
Modal split
Trip Assignment
Service level of transport network
EVALUATION MODEL
Investment cost
Economics evaluation
Benefits and costs (NPV, IRR)
Environmental evaluation

Temporal structure of a transport project : benefits - costs

Benefits - Costs



$$NPV_S = -I_0 + \frac{BS_1 - CS_1}{1+i} + \frac{BS_2 - CS_2}{(1+i)^2} + \ldots + \frac{BS_T - CS_T}{(1+i)^T}$$

$$BS^1 - CS^1 = \frac{1}{2} v\left(\tau^0 - \tau^1\right)\left(q^0 + q^1\right) + p^0\left(q^1 - q^0\right) - \left(C^1 - C^0\right)$$

$$v\left(\tau^0 - \tau^1\right)$$ **Reduction of travel time**

Economic value of travel time

$$v\left(\tau^0 - \tau^1\right)$$

Economic value of travel time **Reduction of travel time**

Differentiated for

Vehicle : car, bus, rail
Mode : car, bus, metro, walk
Passenger : occupant, driver
Hour : peak, no peak
Saturation : congestion
Purpose : work, non work
Zone : in or out CBD

associated with economic transaction

Basic question and objective

Basic question

The research problem of this study is that a specific travel time reduction does not have the same effect

- in a one-hour trip as in one of 20 minutes

- or for a work related trip as for a shopping trip

Objective

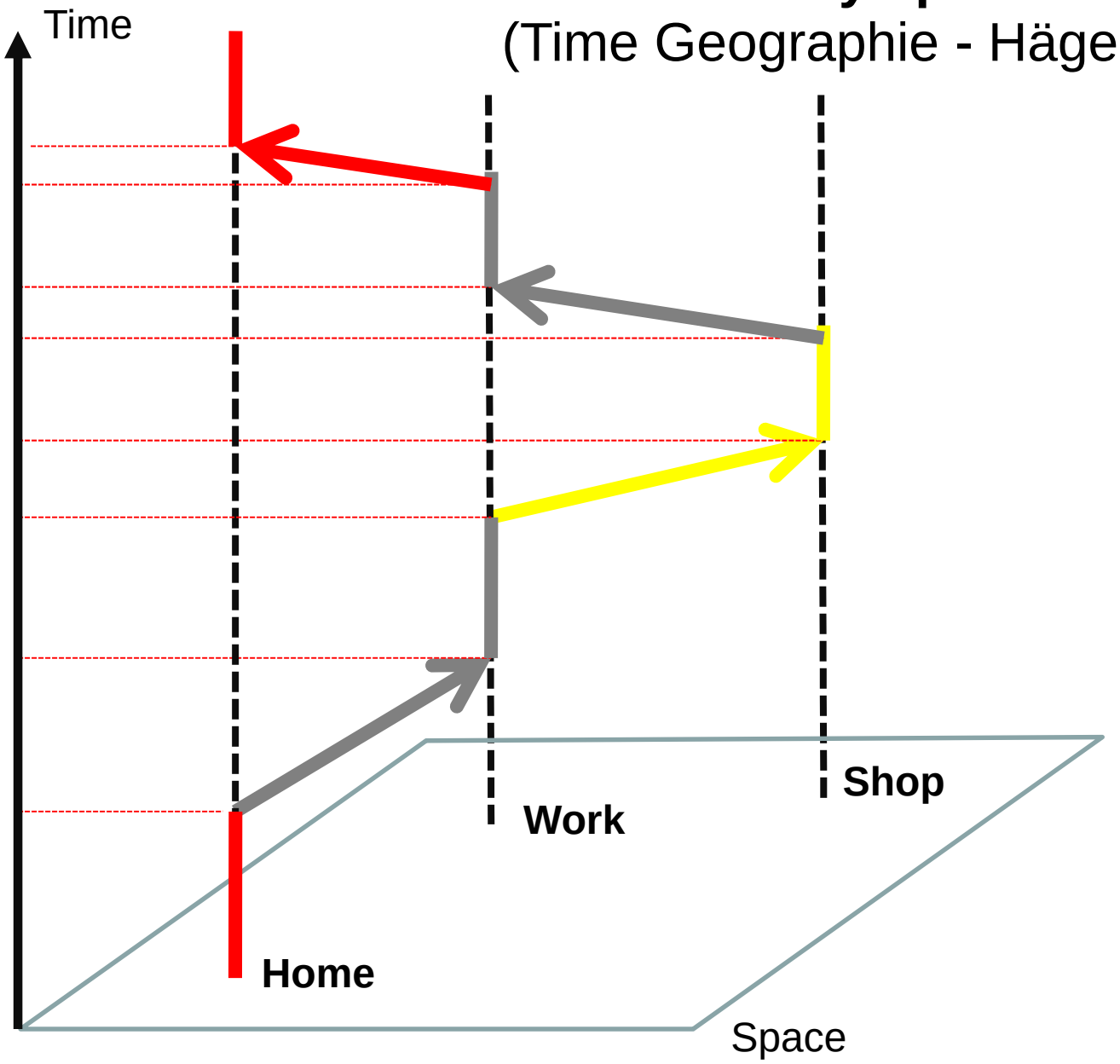
The purpose of the investigation is

1.- to **construct a Pattern of Social Behaviour in the use of the city** (in space and time), and specifically the travel time pattern,

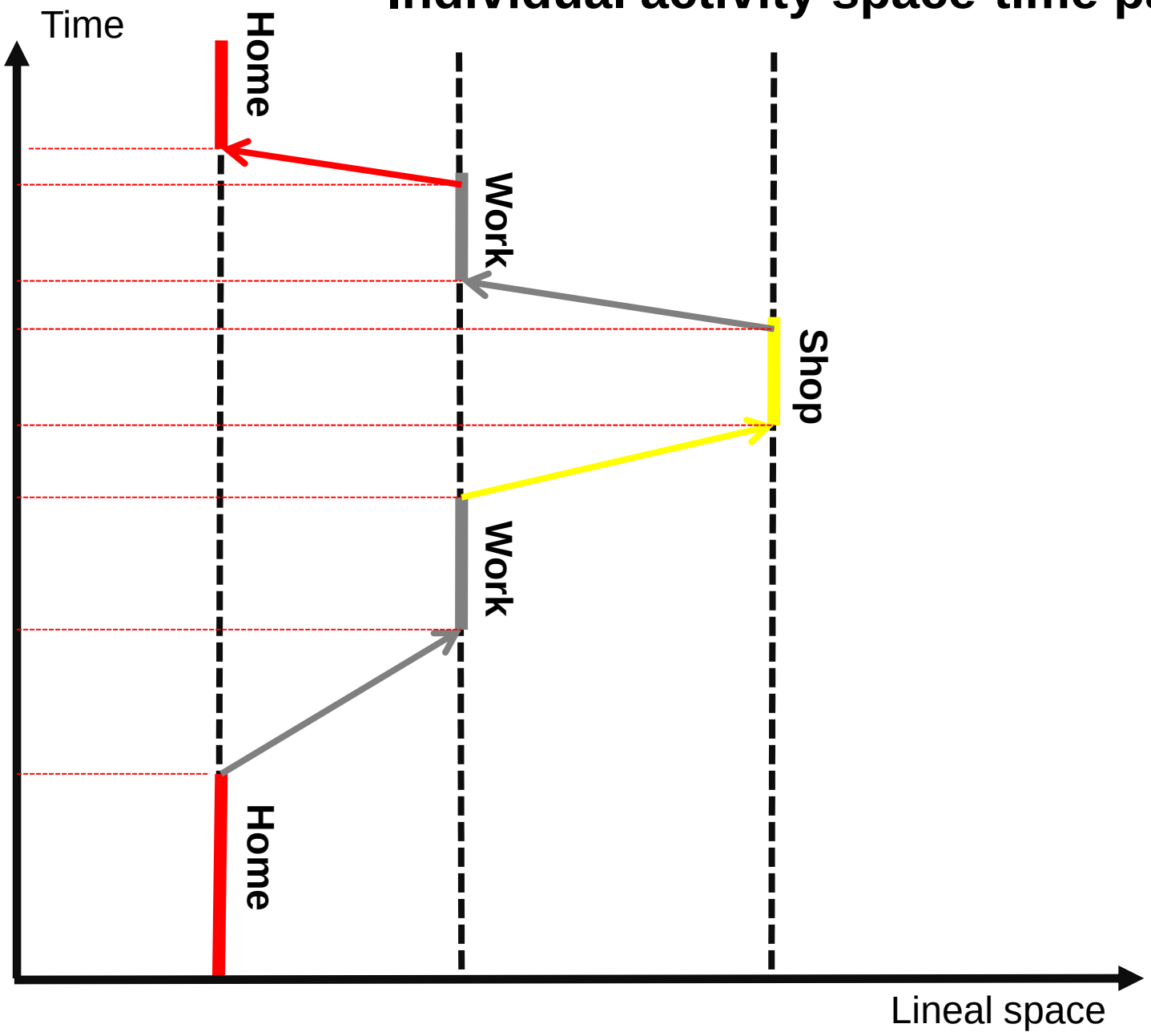
2.- to **use them to prioritise** (under a social equity approach, in travel time) transport corridors, in the Metropolitan Area of Barcelona

Approach (methodology):
the use of the city in space and time

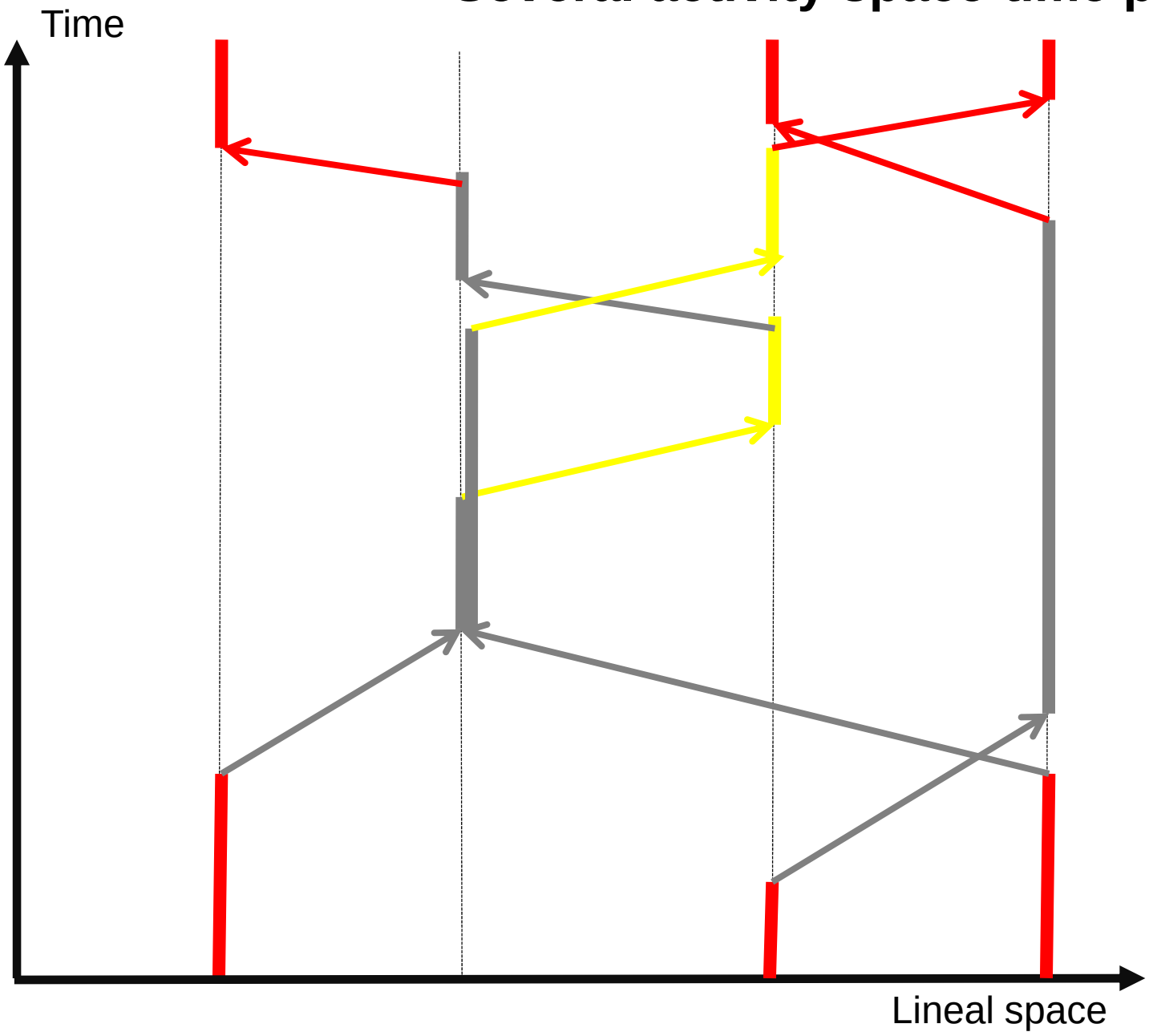
Individual activity space-time path
(Time Geographie - Hägerstrand)

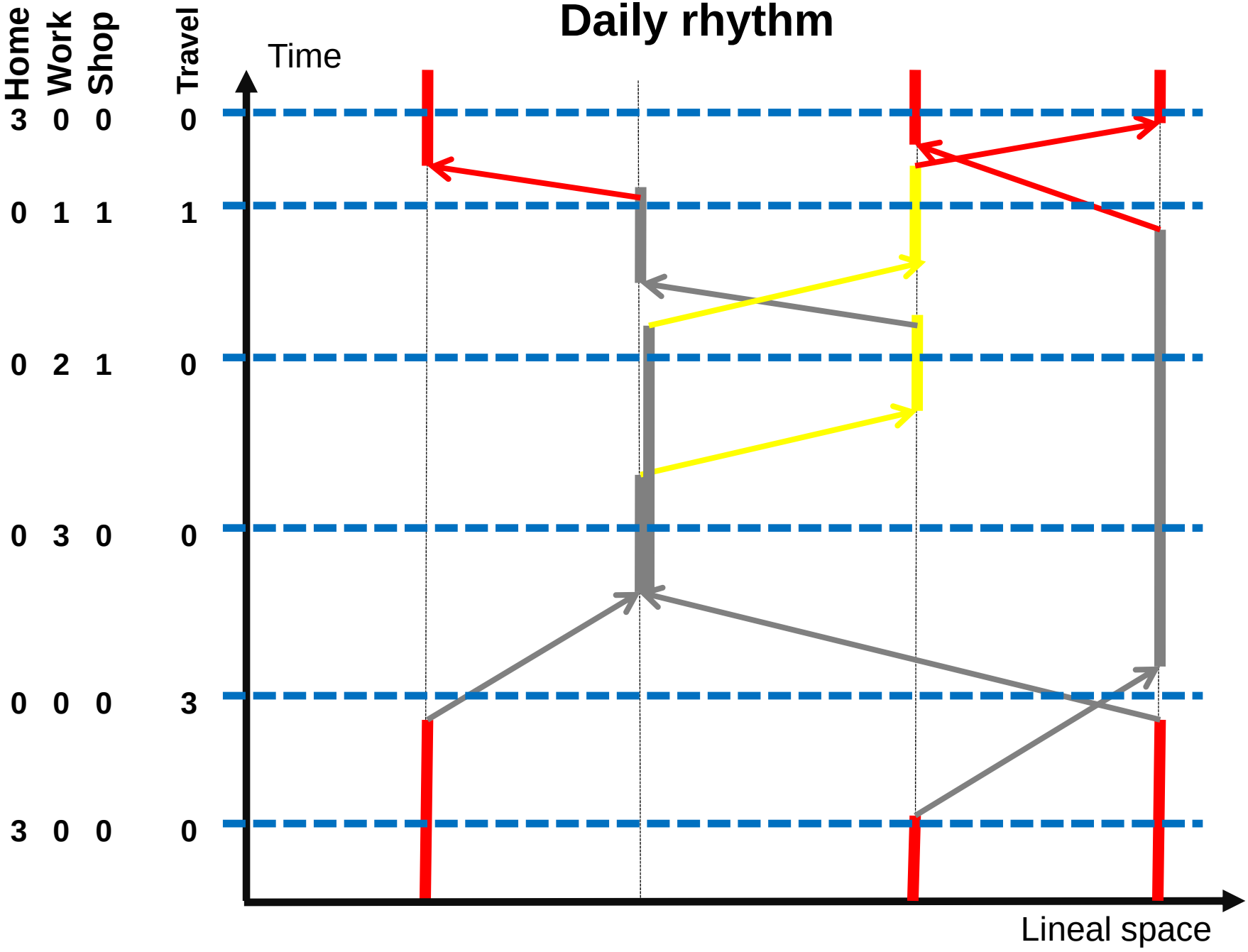


Individual activity space-time path

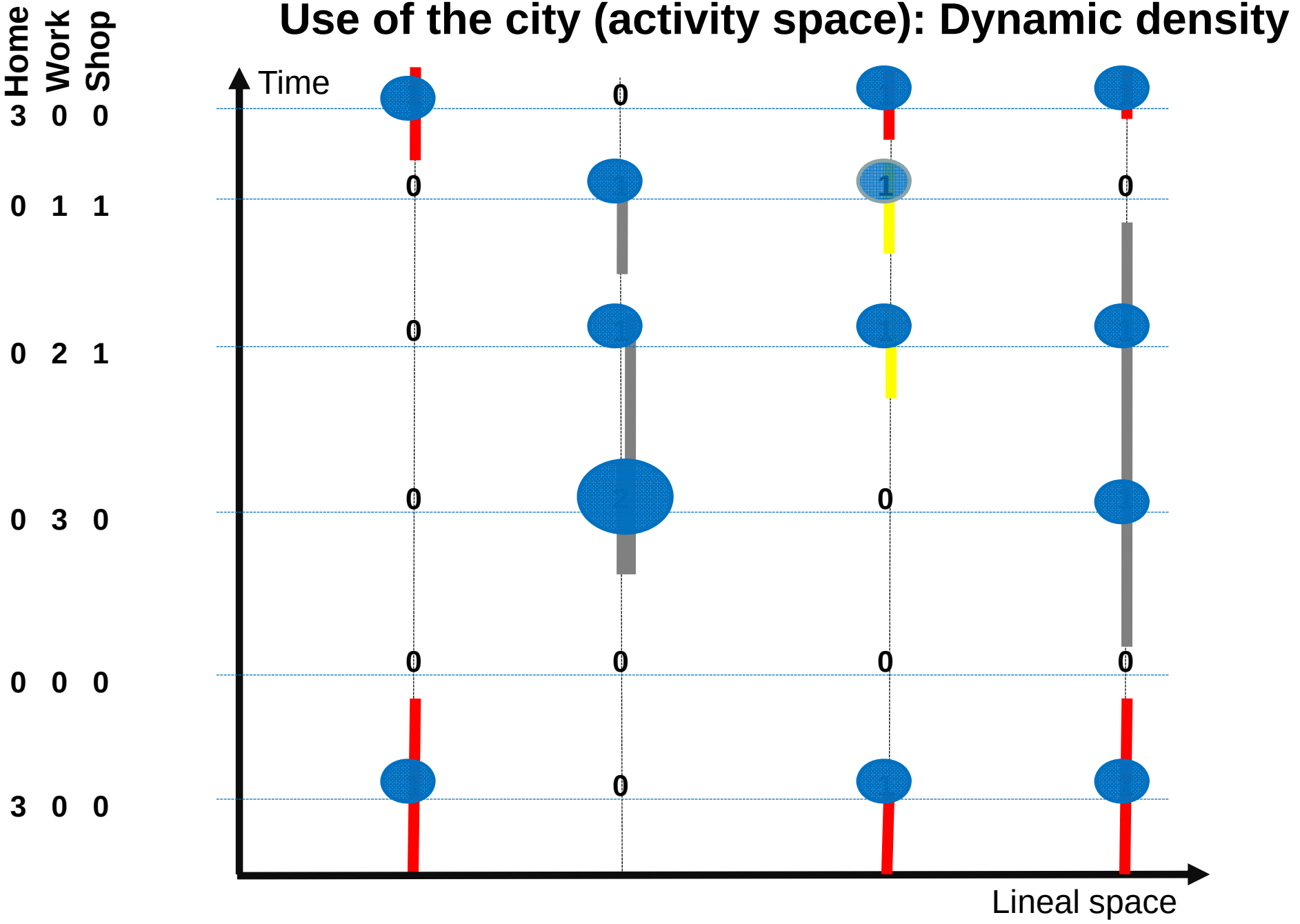


Several activity space-time path

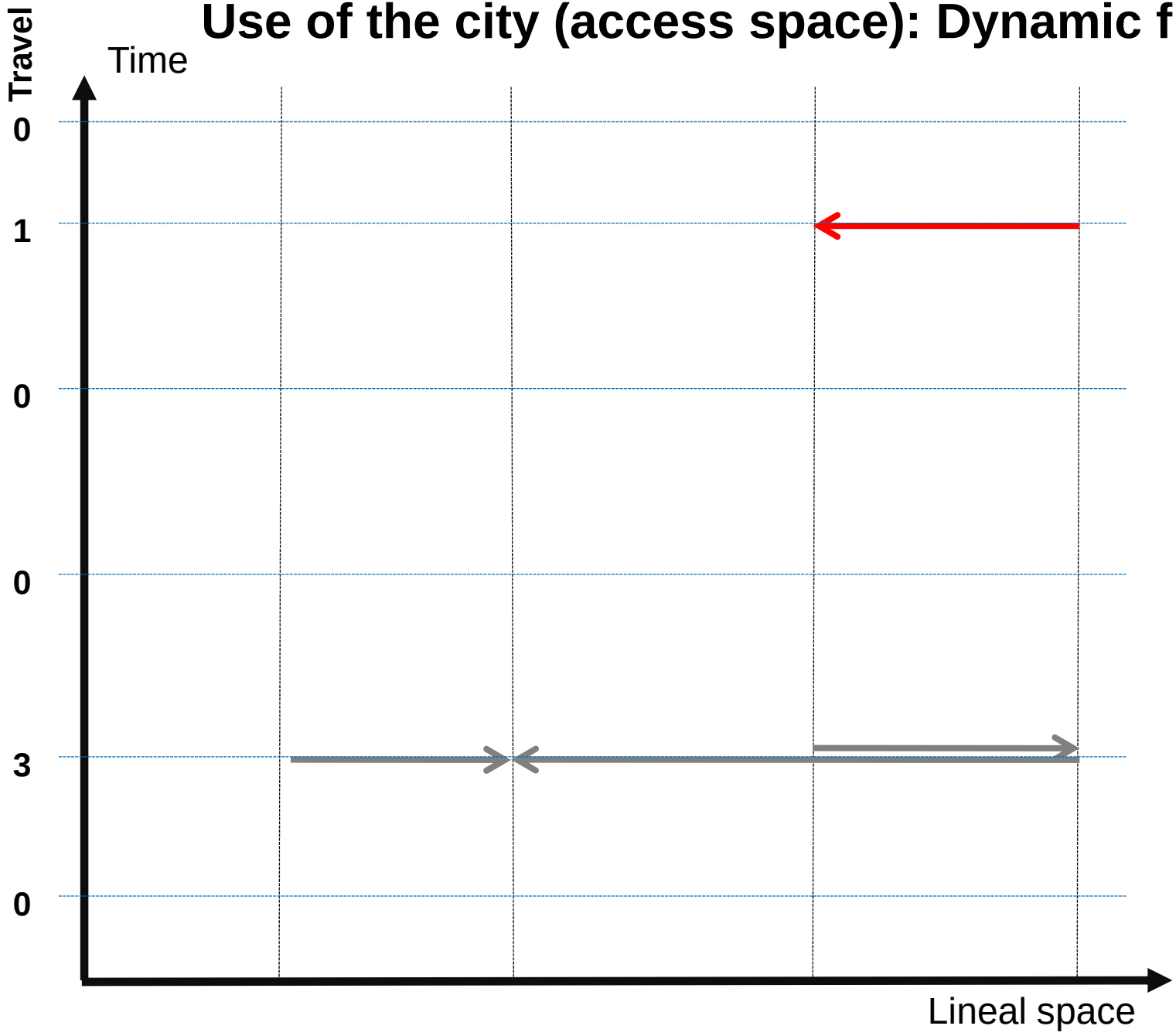



Daily rhythm
Home
Work
Shop
Travel
Time
3 0 0 0
0 1 1 1
0 2 1 0
0 3 0 0
0 0 0 3
3 0 0 0
Lineal space

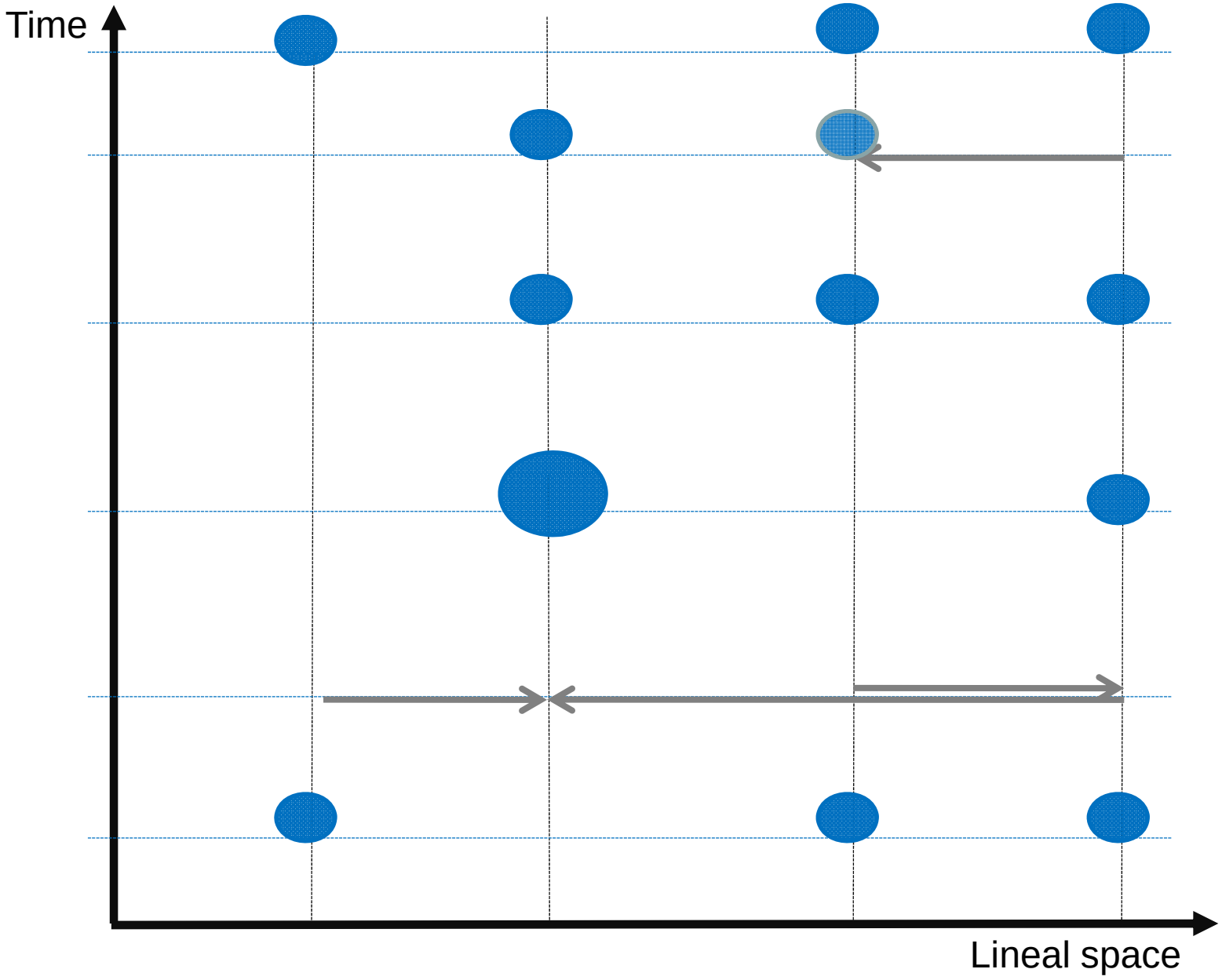
Use of the city (activity space): Dynamic density



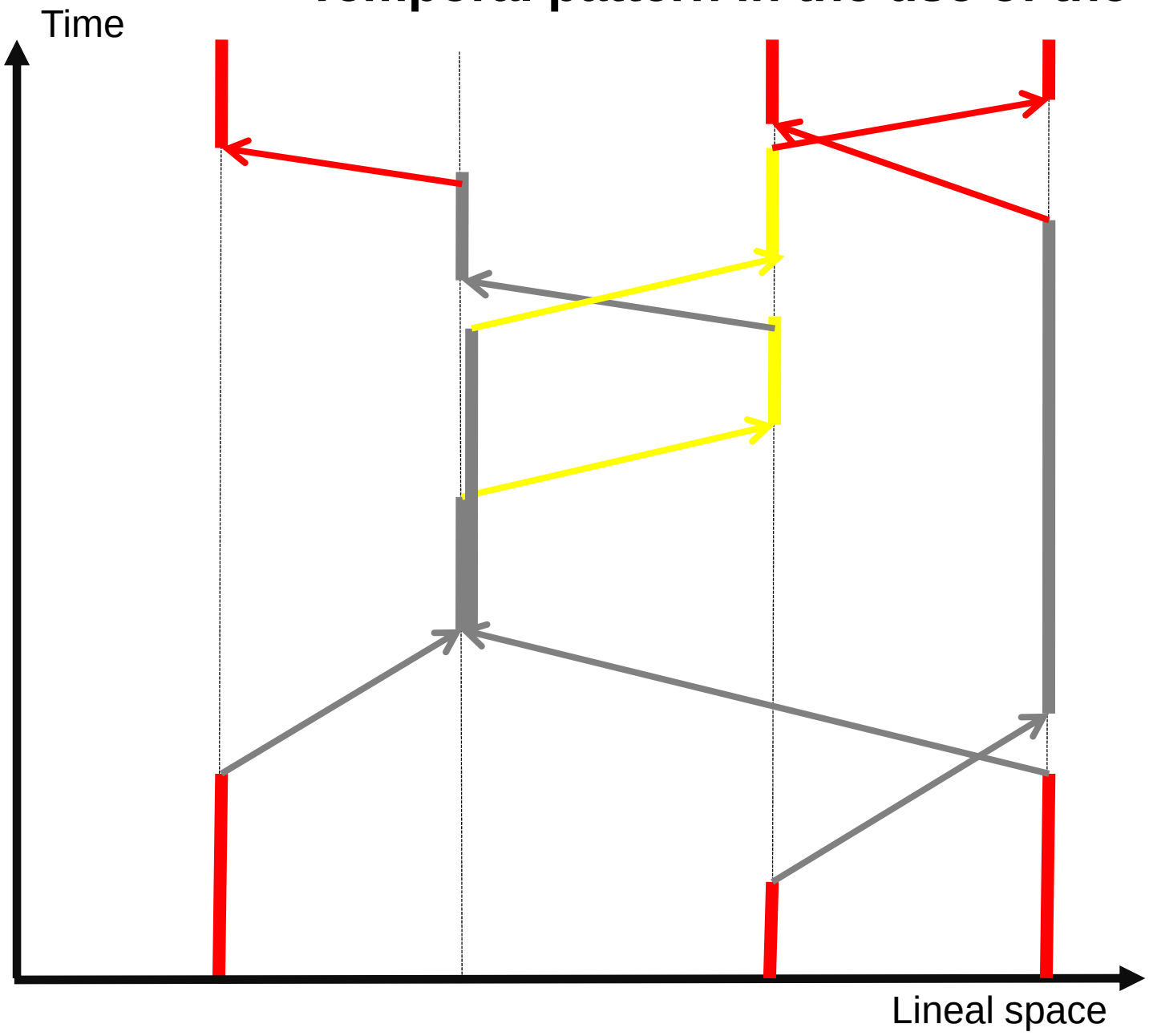
Use of the city (access space): Dynamic flow



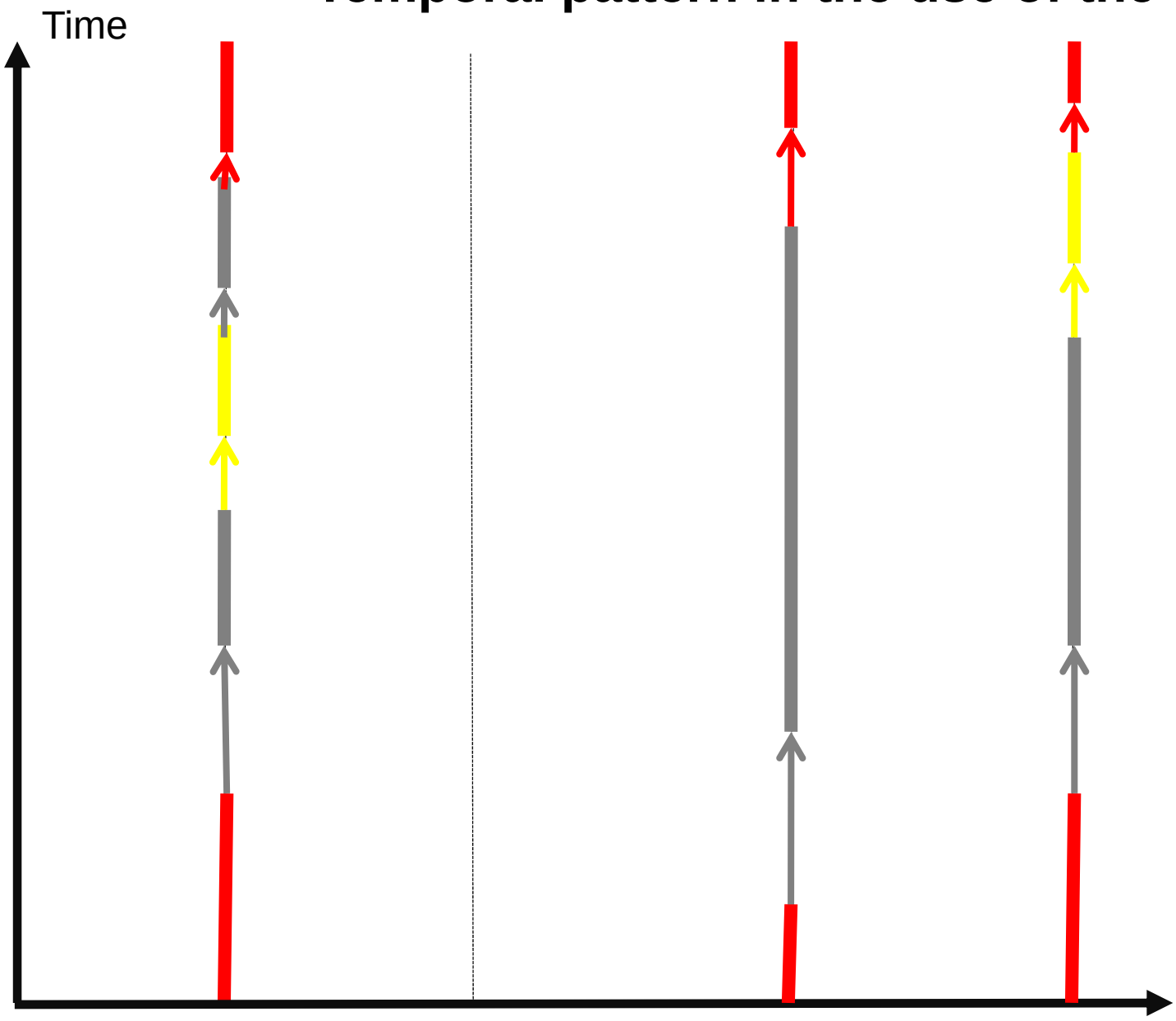
Dinamic use of the city (activity and access space)



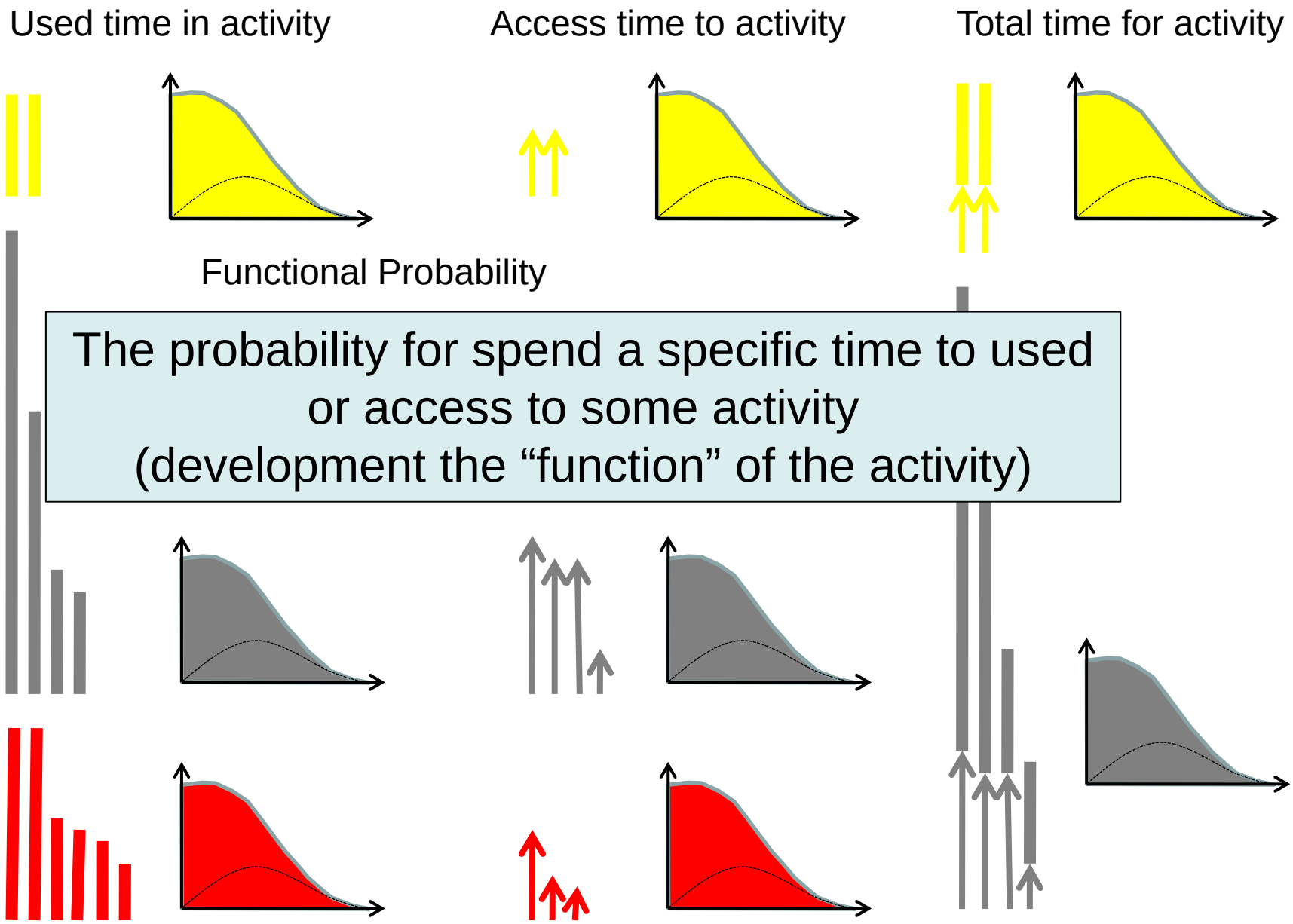
Temporal pattern in the use of the city



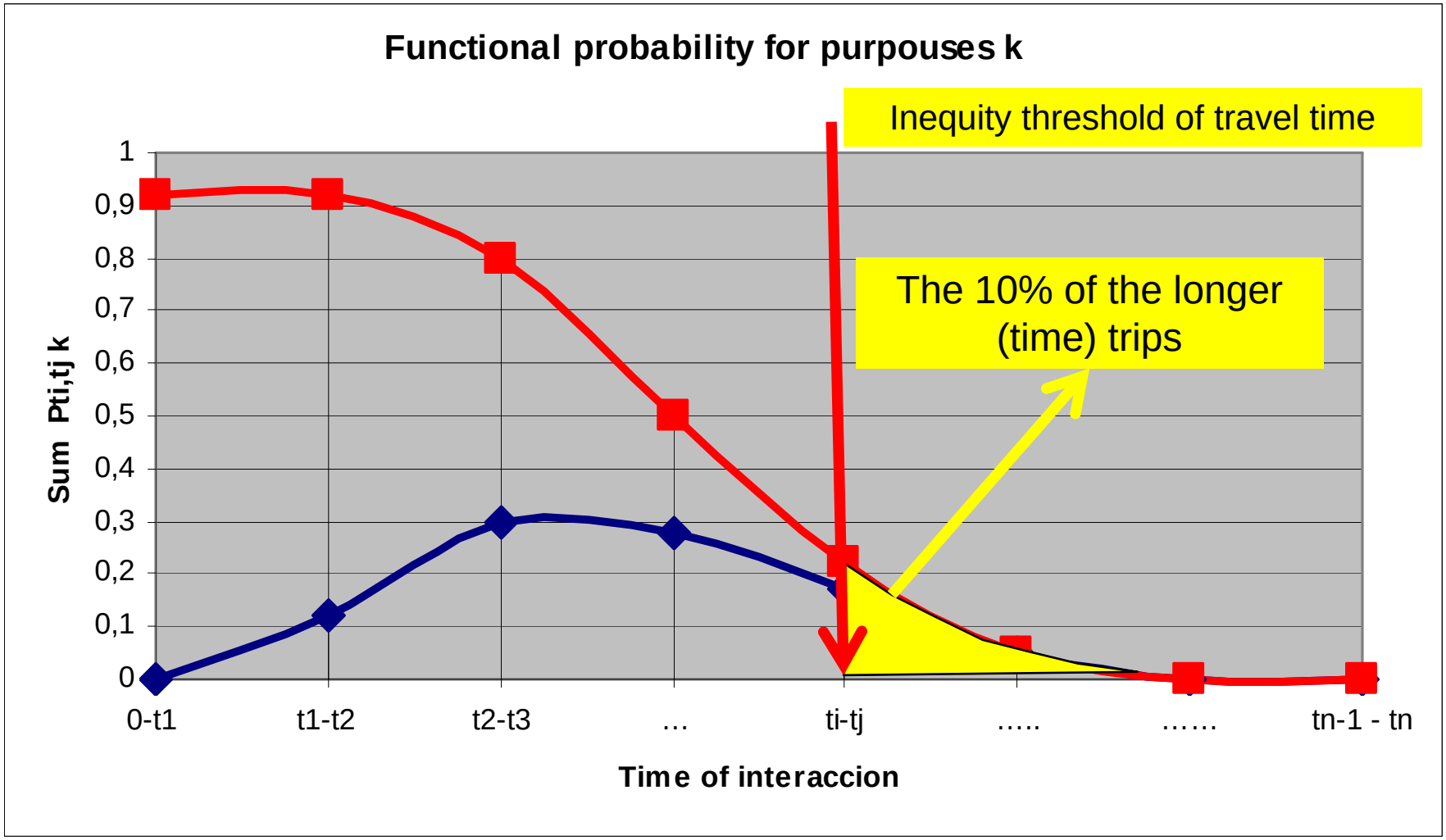
Temporal pattern in the use of the city



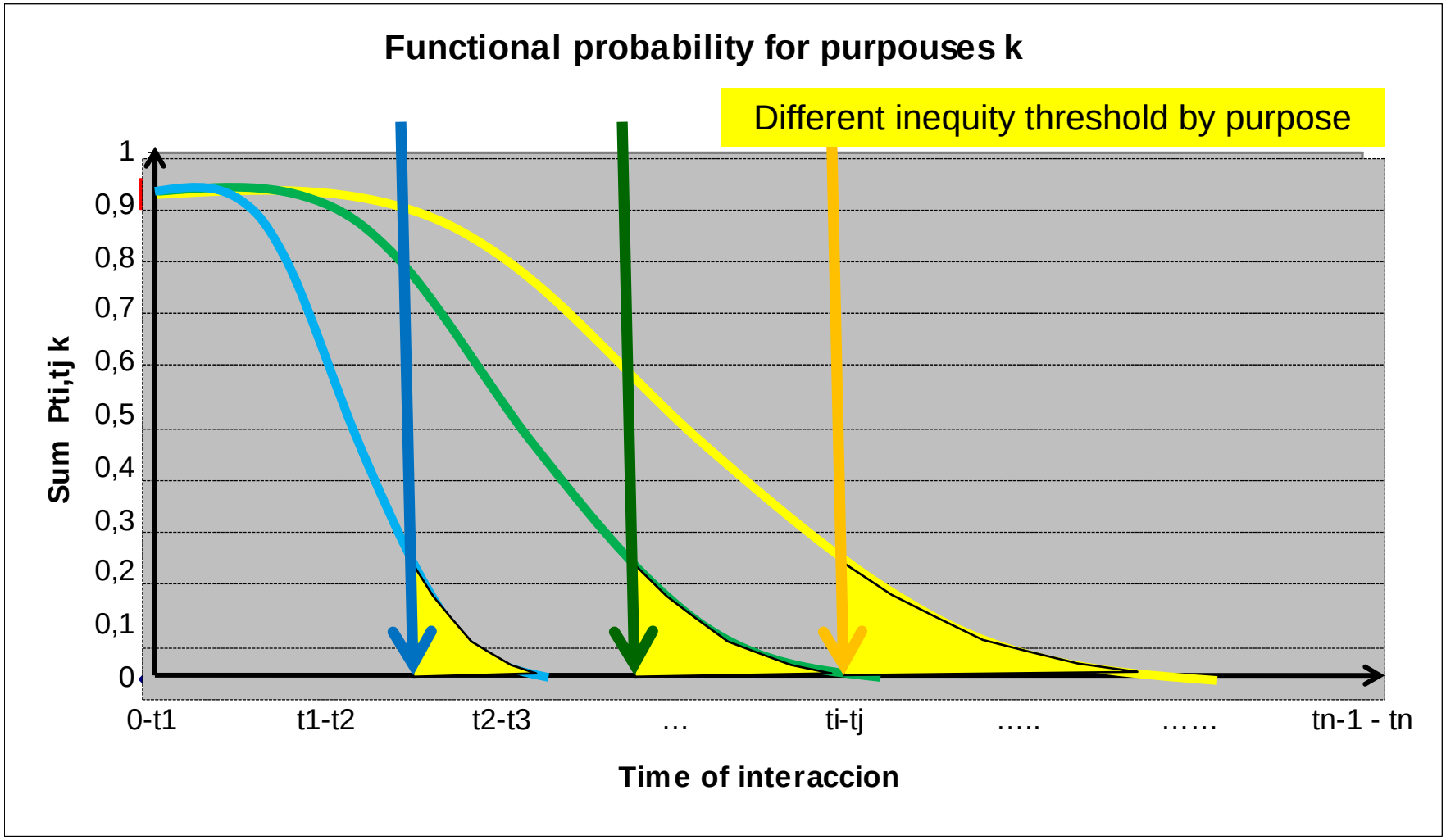
Temporal pattern in the use of the city



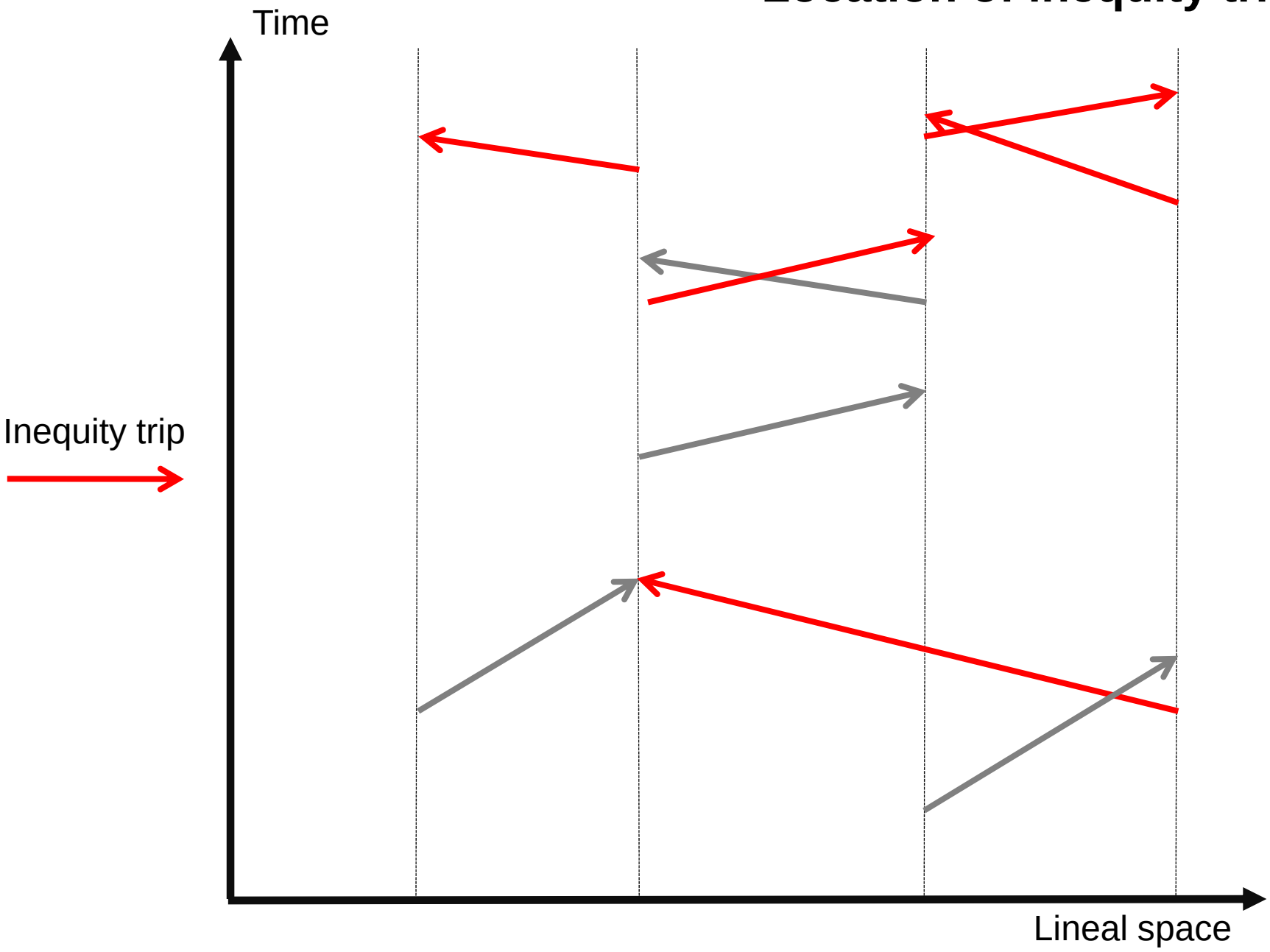
Access time to activity: inequity situation



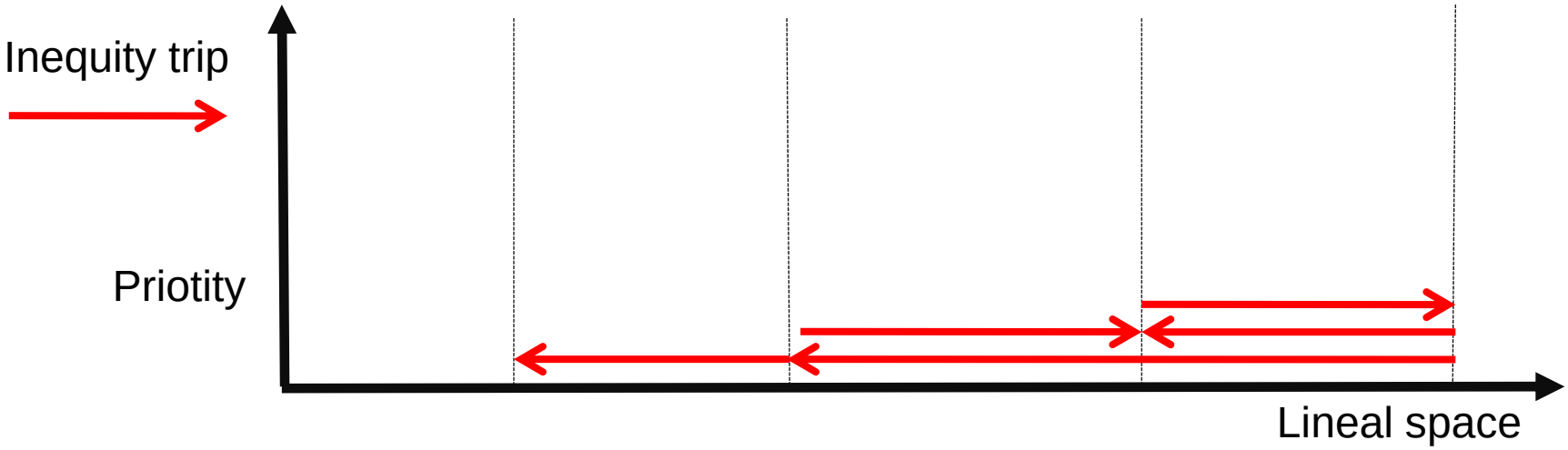
Access time to activity: inequity situation by purposes



Location of inequity trips



Location of inequity trips



Results

Metropolitan Area of Barcelona (2001)

14.515.272 trip per week

Results

Use of the city (activity space): Dinamic density

Activity : Working

Hour : 6:00

Activity : Working

Hour : 7:00

Activity : Working

Hour : 8:00

Activity : Working

Hour : 9:00

Activity : Working

Hour : 10:00

Activity : Working

Hour : 11:00

Activity : Working

Hour : 12:00

Activity : Working

Hour : 13:00

Activity : Working

Hour : 14:00

Activity : Working

Hour : 15:00

Activity : Working

Hour : 16:00

Activity : Working

Hour : 17:00

Activity : Working

Hour : 18:00

Activity : Working

Hour : 19:00

Activity : Working

Hour : 20:00

Activity : Working

Hour : 21:00

Activity : Working

Hour : 22:00

Activity

Working

Shopping

Sparse, entret.

Hour : 06:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 07:00

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Activity

Working

Shopping

Sparse, entret.

Hour : 08:00

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Activity

Working

Shopping

Sparse, entret.

Hour : 09:00

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Activity

Working

Shopping

Sparse, entret.

Hour : 10:00

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Activity

Working

Shopping

Sparse, entret.

Hour : 11:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 12:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 13:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 14:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 15:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 16:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 17:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 18:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 19:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 20:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 21:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Activity

Working

Shopping

Sparse, entret.

Hour : 22:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Results

Use of the city (access space): Dinamic flow

Mobility

To work

.

To shop

Hour : 06:00

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Mobility

To work

To shop

Hour : 07:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Mobility

To work

.

To shop

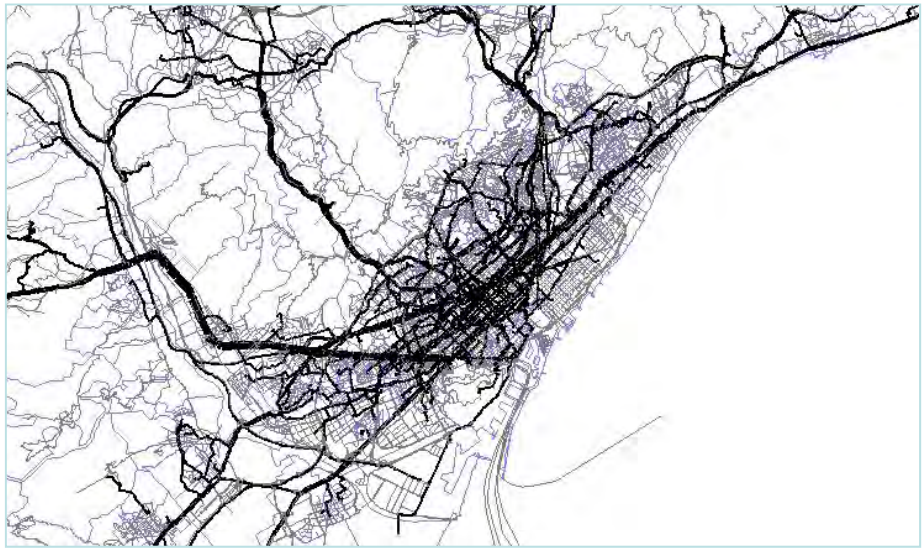
Hour : 08:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Mobility

To work

.



To shop

Hour : 09:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Mobility

To work

.

To shop

Hour : 10:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Mobility

To work

.

To shop

Hour : 11:00

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Mobility

To work

.

To shop

Hour : 12:00

Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Mobility

To work

.

To shop

Hour : 13:00

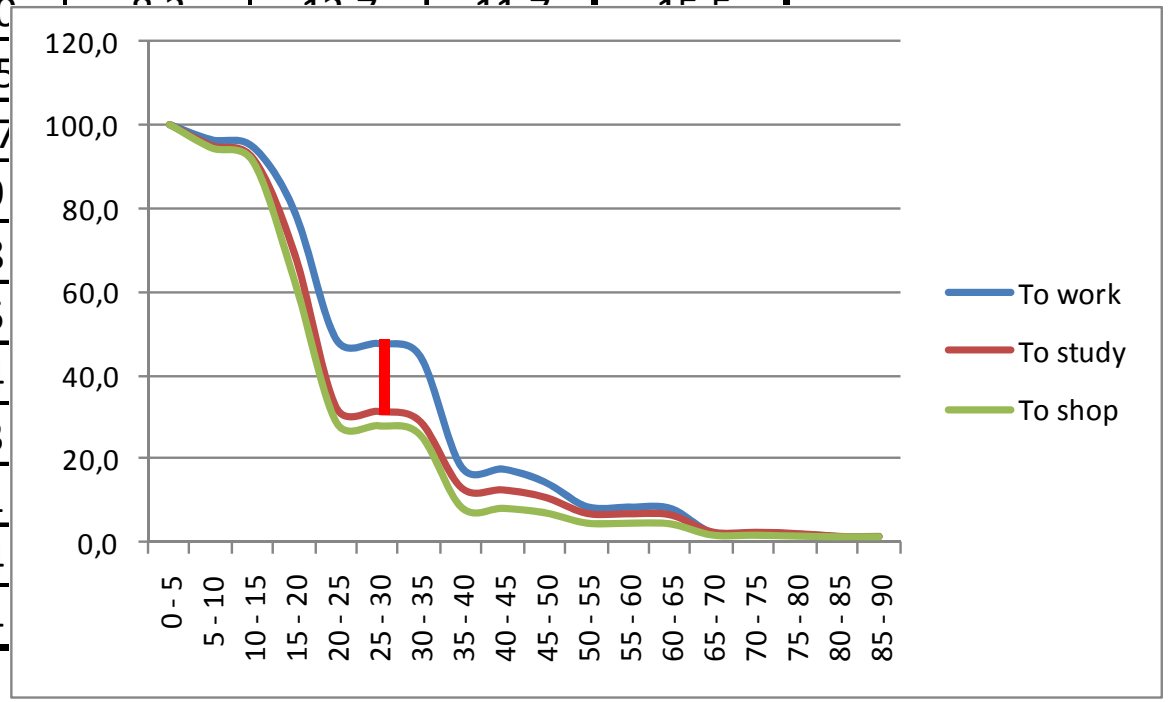
Jorge Cerda, Carlos Marmolejo CPSV-Universitat Politècnica de Catalunya

Results

Temporal pattern in the use of the city
Functional probability

Probability (%)	Purpose					
Travel time (min)	To work	To study	To shop	Leisure	Social	**Total**
0 - 5	100,0	100,0	100,0	100,0	100,0	100,0
5 - 10	96,4	95,0	94,4	94,7	95,7	95,9
10 - 15	94,6	91,9	91,1	92,2	93,2	93,5
15 - 20	79,1	69,0	62,4	74,7	70,0	74,4
20 - 25	48,4	32,1	28,7	38,7	36,3	41,4
25 - 30	47,5	31,3	27,9	37,9	35,3	40,5
30 - 35	44,5	29,0	25,8	35,3	32,3	37,7
35 - 40	17,8	13,0	8,3	13,7	11,7	15,5
40 - 45	17,3	12,5	8,1	13,4	11,4	15,1
45 - 50	14,2	10,7	7,1	11,6	9,7	12,7
50 - 55	8,3	6,9	4,6	5,9	5,2	7,7
55 - 60	8,2	6,8	4,6	5,8	5,1	7,6
60 - 65	7,9	6,5	4,4	5,7	4,9	7,4
65 - 70	2,1	2,4	1,8	1,8	1,8	2,5
70 - 75	2,0	2,3	1,7	1,8	1,8	2,5
75 - 80	1,8	2,1	1,5	1,6	1,6	2,3
80 - 85	1,2	1,4	1,3	1,1	1,0	1,6
85 - 90	1,2	1,4	1,3	1,1	1,0	1,6

Probability (%)	Purpose					
Travel time (min)	To work	To study	To shop	Leisure	Social	**Total**
0 - 5	100,0	100,0	100,0	100,0	100,0	100,0
5 - 10	96,4	95,0	94,4	94,7	95,7	95,9
10 - 15	94,6	91,9	91,1	92,2	93,2	93,5
15 - 20	79,1	69,0	62,4	74,7	70,0	74,4
20 - 25	48,4	32,1	28,7	38,7	36,3	41,4
25 - 30	47,5	31,3	27,9	37,9	35,3	40,5
30 - 35	44,5	29,0	25,8	35,3	32,3	37,7
35 - 40	17,8	13,0				
40 - 45	17,3	12,5				
45 - 50	14,2	10,7				
50 - 55	8,3	6,9				
55 - 60	8,2	6,8				
60 - 65	7,9	6,5				
65 - 70	2,1	2,4				
70 - 75	2,0	2,3				
75 - 80	1,8	2,1				
80 - 85	1,2	1,4				
85 - 90	1,2	1,4				



Probability (%)	Purpose						
Travel time (min)	To work	To study	To shop	Leisure	Social	**Total**	
0 - 5	100,0	100,0	100,0	100,0	100,0	100,0	
5 - 10	96,4	95,0	94,4	94,7	95,7	95,9	
10 - 15	94,6	91,9	91,1	92,2	93,2	93,5	
15 - 20	79,1	69,0	62,4	74,7	70,0	74,4	**33,01**
20 - 25	48,4	32,1	28,7	38,7	36,3	41,4	
25 - 30	47,5	31,3	27,9	37,9	35,3	40,5	
30 - 35	44,5	29,0	25,8	35,3	32,3	37,7	
35 - 40	17,8	13,0	8,3	13,7	11,7	15,5	
40 - 45	17,3	12,5	8,1	13,4	11,4	15,1	
45 - 50	14,2	10,7	7,1	11,6	9,7	12,7	
50 - 55	8,3	6,9	4,6	5,9	5,2	7,7	**0,10**
55 - 60	8,2	6,8	4,6	5,8	5,1	7,6	
60 - 65	7,9	6,5	4,4	5,7	4,9	7,4	
65 - 70	2,1	2,4	1,8	1,8	1,8	2,5	
70 - 75	2,0	2,3	1,7	1,8	1,8	2,5	
75 - 80	1,8	2,1	1,5	1,6	1,6	2,3	
80 - 85	1,2	1,4	1,3	1,1	1,0	1,6	
85 - 90	1,2	1,4	1,3	1,1	1,0	1,6	
	15,57		**28,71**				

	Purpose threshold (min)					
Percentil	To work	To study	To shop	Leisure	Social	**Total**
50	19,7	17,6	16,8	18,4	18,0	18,7
75	33,6	31,2	30,2	32,4	31,8	32,9
90	48,6	46,0	34,5	46,4	44,0	47,7
95	62,5	61,9	49,2	60,9	58,2	62,5
99	69,9	75,7	64,6	64,7	64,7	77,0

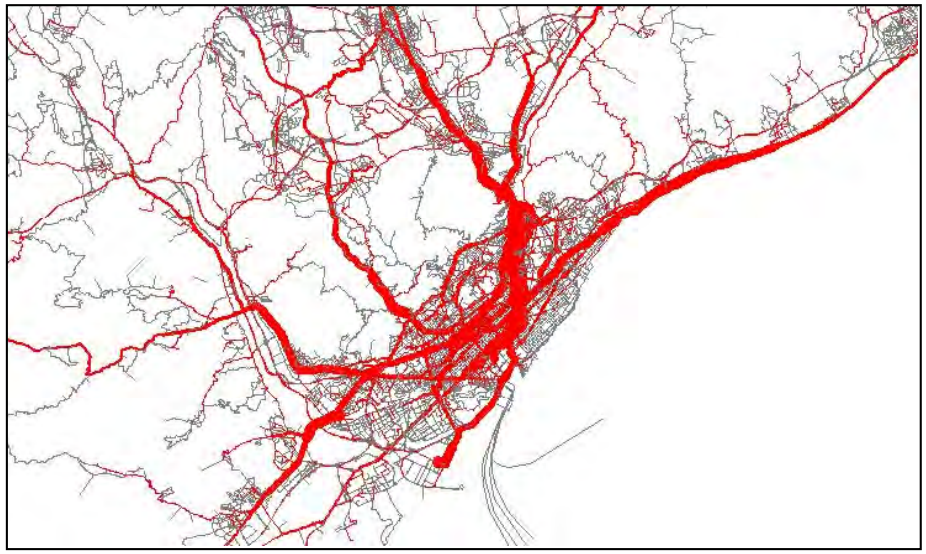
Total trips (week)	**:**	**14.515.272**
Inequitable trips	**:**	**1.071.253 (7,38%)**

Low educational class	**:**	**55%**
Midle class	**:**	**27%**
High class	**:**	**18%**

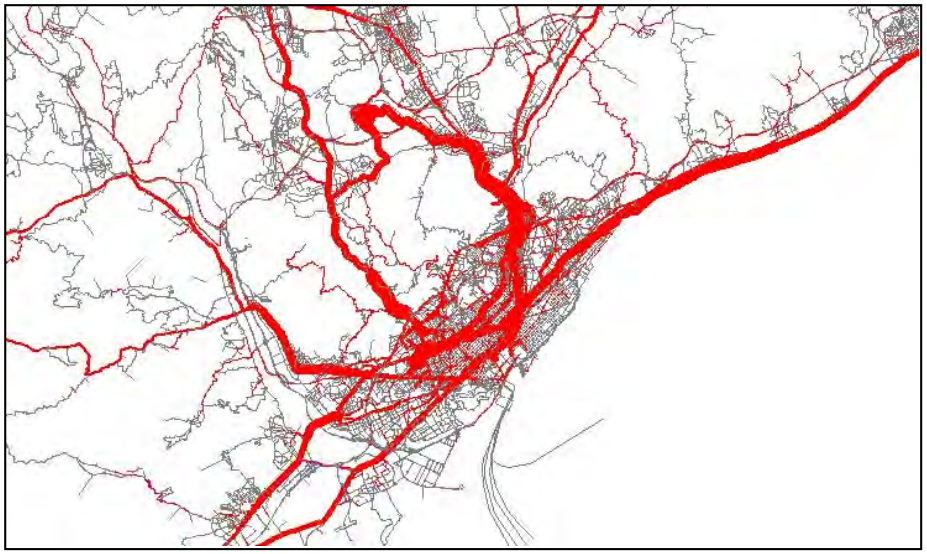
To work	**:**	**41%**
To study	**:**	**22%**
To shop	**:**	**7%**
Leisure	**:**	**4%**
Social	**:**	**7%**
Others	**:**	**19%**

Walking or bike	**:**	**19%**
Car	**:**	**21%**
Bus	**:**	**18%**
Metro	**:**	**16%**
Train	**:**	**26%**

The inequitable travel to work

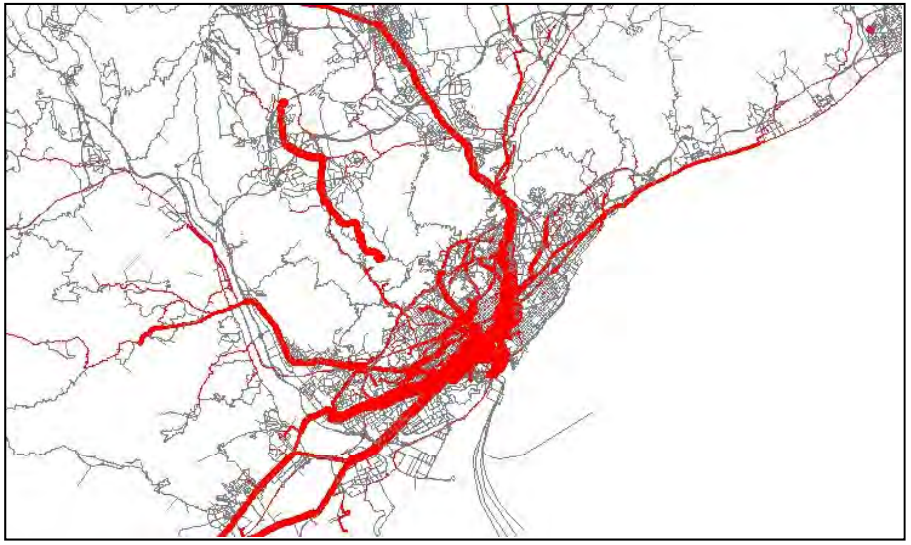


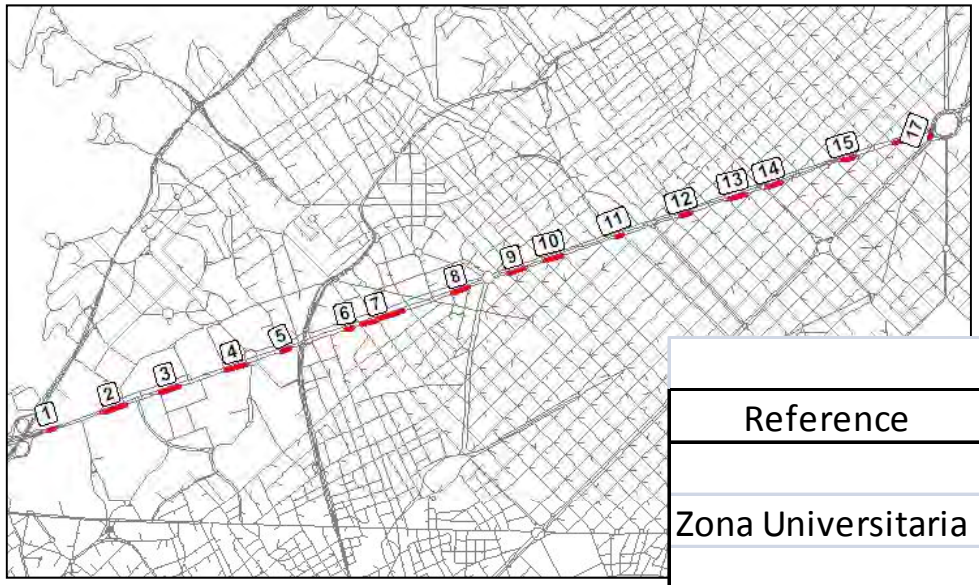
The inequitable travel to study



The inequitable travel to shop

The inequitable leisure trips





		Specialization in inequity travel				
Reference	Point	To work	To study	To shop	Leisure	Social
	1	3,0	3,8	11,4	1,4	11,0
Zona Universitaria	2	3,1	4,5	12,0	3,1	12,2
	3	3,0	4,0	10,7	3,1	12,2
	4	2,8	3,8	10,0	3,1	12,2
Pl. Maria Cristina	5	2,8	4,6	9,8	3,2	12,1
	6	2,8	4,5	7,4	3,2	10,7
	7	3,0	4,6	7,4	3,3	10,7
Pl. Francesc Macia	8	2,0	4,8	5,3	2,0	10,3
	9	1,9	4,1	4,7	1,0	12,5
	10	1,8	3,8	4,1	1,1	11,1
Psg. Gracia	11	1,6	4,3	3,0	1,4	7,6
	12	1,4	4,1	4,0	1,3	5,2
	13	1,4	4,2	3,5	0,8	5,2
Psg. Sant Joan	14	1,4	4,2	3,3	1,0	5,2
	15	0,8	0,0	3,5	0,0	5,0
Pl. Glories	16	0,9	0,0	3,8	0,0	3,5

Main conclusions

Travel time is a random variable of mobility, usually a-traditionally use the average travel time, but as shown, the travel time is a random variable of mobility, whose statistical distribution is not usually symmetrical. So, it would be wrong to use the average time as a representative value.

The functional probability shows a “willingness to spend time on travel”, in other words it is the probability to make or not the trip, for a specific purpose. Then the variation of probability produced by a reduction of time is not constant as the social value of time.

Journeys with inequitable travel time, identified by a statistical approach, are concentrated in 1) the lower class, but also with a significant percentage in the higher class, 2) in travel to work, but all the other purposes together have a greater percentage, and 3) with homogeneous modal distribution. These non-traditional characteristic of inequity show the dimensions that provide the approach of the social use of the city, to the inequity in urban transport.

The Barcelona transport corridors are specialised in space and purpose. The specialisation profile of a specific corridor shows the potential social benefits of investment in transport, in terms of reducing inequities in travel times of different purposes of the use of the city. With this approach, the real benefits of transportation projects are evaluated in terms of the trip chain, and not only in specific sections of the network.

The main conclusion of the research is that by taking a social view of travellers, with regard to their different purposes and social class, in the form of how they use the city in terms of space and time, is An additional criteria, with urban approach, a more realistic criterion to prioritise different transport corridors, by carrying out the analysis of who makes use of them, for what reason, and for how long.